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CERTIFICATE

This certificate is issued in support of an application for Patent registration in a country outside New Zealand pursuant to the Patents Act 1953 and the Regulations thereunder.

I hereby certify that annexed is a true copy of the Provisional Specification as filed on 16 March 1999 with an application for Letters Patent number 334695 made by MEGADOT SYSTEMS LTD.

Dated 17 March 2000.

PRIORITY DOCUMENT
SUBMITTED OR TRANSMITTED IN COMPLIANCE WITH RULE 17.1(a) OR (b)

Neville Harris

Neville Harris
Commissioner of Patents

334695

NEW ZEALAND

PATENTS ACT, 1953

No:

Date:

COMPLETE SPECIFICATION

IMPROVEMENTS RELATING TO HALFTONE GROWTH PROCESSES

We, MEGADOT SYSTEMS LIMITED, a New Zealand company of 3/61 Taranaki Street, Wellington, New Zealand, do hereby declare the invention for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:

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16 MAR 1999

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FIELD OF THE INVENTION

This invention relates to halftone printing processes and in particular to patterns of printing areas which may be used for preparing coloured images. These patterns include arrangements of the printing and non-printing areas, and particularly variation of these areas to create varying tone, which reduce the occurrence of moire and other effects in an image.

BACKGROUND TO THE INVENTION

Halftone processes suffer a number of problems including moire, line effects and tone jump. Production of images using these processes involves a compromise between the perceptible impact of different undesirable effects. Reference is made to US 5,680,222 from the present inventor for background information on these effects.

Moire includes both large and small scale effects due to periodic alignment of the halftone dots which are used to represent different colours and black. Spurious patterns including lines and rosettes have frustrated printers for many years. Colour shift occurs when the dots of different colours or black overlap more or less than intended due to misregistration of their respective patterns. A slight displacement of the patterns or stretching of the print medium can cause an inaccurate reproduction of the original colours. Methods have been proposed to reduce these effects with varying degrees of success in varying circumstances.

Line effects occur where printing or non-printing areas having an elongated or linear shape create a perceptible array of parallel lines in an image. The effect depends partly on the angle of elongation with respect to horizontal and partly on the underlying pattern. Lines which are formed at 45 degrees on a square pattern are generally less perceptible than horizontal lines, for example. Tone jump or dot gain occurs when adjacent printing or non-printing areas become sufficiently large as to merge unintentionally due to physical effects in their reproduction. Surface tension in particular causes thin strands of ink to join or break to create a larger or smaller printing area than intended.

Traditional halftone patterns are "orthogonal" in that the printing areas lie on a square or rectangular mesh . Every colour "screen" generally takes the same format with a different spacing between the lines of the mesh and a different angle from horizontal. There have

been few, if any, successful attempts to vary the orthogonal nature of the screens or variation in the printing areas with respect to these screens.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide patterns which can be used to reduce one or more of these undesirable effects in halftone images. Accordingly the invention may broadly be said to consist in a combination of non-orthogonal patterns with variation of the printing areas along predetermined directions in the patterns.

In one aspect the invention may be said to consist in a pattern for use in production of a halftone image, wherein: printing areas define a non-orthogonal minimum mesh and extend first with darkening tone along directions other than those of their closest spacing.

In another aspect the invention may be said to consist in a screen system for use in production of a coloured halftone image, wherein: a plurality of different screens each represent different colours or black in the image, each screen has a pattern of printing areas which defines a minimum mesh, the minimum meshes of at least two screens are non-orthogonal and have printing areas which extend to join first along directions other than that of their closest spacing.

In a further aspect the invention may be said to consist in a method of preparing a halftone pattern, comprising: receiving information representing tone variation in an image, creating a pattern of printing areas which represents the variation by; forming the pattern to define a non-orthogonal minimum mesh, and varying the printing areas by extension toward nearby areas other than their nearest neighbours.

The invention may also broadly be said to consist in any alternative combination of features as described or shown in the accompanying drawings. Known equivalents of these features not expressly set out are nevertheless deemed to be included.

BRIEF DESCRIPTION OF THE DRAWINGS

Preferred embodiments of the invention will be described with respect to the drawings, of which:

Figures 1a to 1d are four halftone patterns having a common tone density and different arrangements of printing areas,

Figures 2a to 2d are the four halftone patterns with each defining a non-orthogonal mesh over the printing areas,

Figures 3a and 3b are combined patterns and meshes for Figures 2a, 2c and 2b,2d respectively,

Figures 4a to 4d are the four patterns with extended printing areas creating a darker tone,

Figures 5a and 5b are combined patterns and meshes for Figures 4a, 4c and 4b, 4d respectively,

Figures 6a to 6d are four patterns showing variation of the printing areas with respect to a mesh to create tone variation,

Figure 7 demonstrates the combined patterns and meshes of Figures 2a to 2d,

Figure 8 demonstrates the combined patterns of Figures 4a to 4d,

Figure 9 is a flowchart indicating general processes by which a halftone image may be produced, and

Figure 10 is a schematic diagram indicating a computer-based system by which the processes of Figure 9 may be implemented.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to the drawings it will be appreciated that the various novel patterns must here be printed in black and white, and magnified by up to perhaps 1000x for the purposes of a clear description. It is not possible to demonstrate their full advantage under these circumstances. Also that the patterns and various shapes of the printing and non-printing areas may be implemented by an appropriate mathematical construction of a spot function or a threshold array, using a wide range of hardware and software which are already available. Details of the hardware and software are largely left to the skilled reader, with reference to US 5,680,222 and further references therein, for example.

A typical process for preparing a halftone image is outlined in Figure 9. In general terms the image is scanned or otherwise recorded by a suitable digital process and the resulting information is stored as pixel based colour and intensity data. The pixels are generally aligned with vertical and horizontal directions of reference such as the directions of scanner movement. This data is then processed into a standard format such as POSTSCRIPT and from there into a number of halftone patterns which are traditionally

known as "screens". In current processes there may be four or more screens which represent a range of different colours and black, as required.

The patterns are generally created from the pixel information by raster image processing software commonly known as a "rip", which calculates the locations, spacings and shapes of the printing areas. An operator normally has a range of standard patterns installed on the equipment and may be able to develop variations of these patterns in some cases. Traditional calculations involve screen frequencies and angles although more sophisticated equipment enables patterns to be created without reference to these parameters. The operator is able to proof and modify the selection of patterns to minimise various effects such as moire, colour shift and tone jump according to the subsequent reproduction technique. A coloured image can be output in various ways depending on the manner in which the image will be published and the equipment which is available. The patterns may be produced on film for inspection before printing plates such as used in offset printing are created. Sometimes the plates are produced directly. In other processes such as desktop publishing an image combining the patterns may be output directly through a laser printer or other printing device.

Typical computer controlled equipment for production of halftone patterns and images is shown in Figure 10. The patterns are schematically indicated at the output stage according to the CYMK system which describes a coloured image in terms of the primary subtractive colours cyan, magenta, yellow and black. An image may be input to the system from a scanner 11, a computer tracing system 12, or from information already stored on a medium such as disk 13. An operator is able to process the input by way of controls on the scanner or the keyboard of the system 12. A separate dedicated system 13 is often used to convert pixel data into the halftone patterns. This includes a separate CPU 14 and screen processor 15 which contains the RIP. Output from the screen processor in this example is used to control the operation of a laser plotter 16 which produces film for use in production of plates for a printing press 19. Feedback control of the plotter involves a beam controller 17 and beam indicator 18. Details of the computer controlled equipment and alternative systems which might be used are beyond the scope of this specification.

Figures 1a, 1b, 1c, 1d show four halftone patterns which might be considered as parts of different colour "screens" in a traditional printing system. In the present case however, they should be considered simply as patterns viewed from horizontal with respect to the image. They represent different colours or black in a general sense without limitation to

screen related parameters such as dot frequencies and angles. The printing areas in each pattern are composed of conventionally shaped round dots which grow in size and shape in various ways, and may join in darker tones, according to variations in tone across the particular image. A uniformly light tone is presented by way of example and a similar pattern of non-printing areas would preferably appear in darker tones. It will be appreciated that a wide range of possible dot shapes and growths may be implemented in practice. It is primarily the arrangement of these printing areas with respect to each other which forms the subject of the present invention. The patterns might be considered as representing cyan, magenta, yellow and black in a typical four colour image.

Figures 2a, 2b, 2c, 2d show the patterns of Figures 1a, 1b, 1c, 1d each with a superimposed mesh formed by two sets of parallel lines which pass through the dots. The meshes are "non-orthogonal" in that the sets of lines intersect at other than right angles and are not perpendicular. Each mesh has a repeating unit which takes the shape of an oblique parallelogram such as a rhombus with four equal length sides or a rhomboid with two pairs of different length sides. The meshes are also "minimum" in that the sides of each parallelogram are formed by the shortest or second shortest distances measured between the centres of the dots. The repeating unit may be either a rhombus with four shortest sides or a rhomboid with two shortest and two second shortest sides. A large number of meshes may be defined for each pattern including both orthogonal and non-orthogonal lines. However, it is believed that any pattern can have only a single minimum mesh of this kind. The minimum mesh is not necessarily used in calculation of the pattern but will usually be defined by consideration of a finished arrangement of printing areas determined by some other process.

Figures 3a and 3b demonstrate pairs of patterns in combination showing their underlying minimum meshes. They are taken from the patterns of Figures 2a, 2c and 2b, 2d respectively and could for example, represent combinations of cyan, magenta and yellow, black. The visual aspect of the combined patterns is somewhat deceptive in that the different colours have different intensities in themselves, with yellow being considerably less intense than black. However, it will be seen that the printing areas in these patterns have been arranged in a way which reduces their overlap in light tones. It is impossible to eliminate all overlap throughout an image because the printing areas will necessarily grow and overlap in darker tones, with corresponding shrinkage and separation of the non-printing areas. However, it has been found that printing areas are conveniently arranged in this way with reference to a non-orthogonal mesh. The patterns are also preferably

selected according to a repeating parcel of printing areas which is of common shape, size and/or orientation among some or all of the patterns.

Figures 4a, 4b, 4c, 4d show the patterns of Figures 1a, 1b, 1c, 1d with preferred forms of dot growth as would be created for darker tones. In general terms the printing areas of each pattern become ovals which enlarge first in an initial direction as shown, and then in another. A wide range of dot shapes may be selected however, such as the pincushion shapes of US 5,680,222. The areas of each pattern eventually join in two distinct stages resulting from their growth in two different directions. This reduces the effects of tone jump. The directions of growth avoid the shortest distance between printing areas and preferably lie along the second and third shortest distances between printing areas, as shown. Growth along the shortest distance of a minimum mesh will usually produce perceptible line aspects in the image.

Figures 5a and 5b demonstrate pairs of patterns in combination showing their initial directions of growth in the printing areas. They are taken from the patterns of Figures 4a, 4c and 4b, 4d respectively and could for example, represent combinations of cyan, magenta and yellow, black. For these particular combinations of colours the areas would normally grow in perpendicular directions to create darkening tone.

Figures 6a, 6b, 6c, 6d show variation in the printing areas with respect to the minimum mesh. In Figure 6a the pattern of printing areas defines a minimum mesh having a rhombus as the repeating unit, such as shown in Figure 2a. Printing areas grow first in one of the directions of their second closest spacing which lie diagonally across the unit. As tone darkens still further the areas grow in a direction which lies perpendicular to the first. Figure 6b shows a pattern where the order of these directions is reversed. The areas may or may not join before growth begins in the other direction and various processes are possible.

In Figure 6c the pattern of printing areas defines a minimum mesh having a rhomboid as the repeating unit, such as shown in Figure 2b. The printing areas extend first in the second shortest direction which lies along the longer side of the unit. Figure 6d shows a pattern where the areas extend in the third shortest direction which lies across diagonally across the unit.

Figures 7 and 8 are provided as an attempt to demonstrate the nature of an image combining four patterns according to the invention. They are taken from the patterns of Figures 4a, 4b and 6a, 6b respectively. The absence of any significant moire or line effect can be seen although it is impossible to indicate the absence of other colour effects. Misregistration of the patterns does not cause any significant colour shift, for example.

WHAT WE CLAIM IS :

1. A pattern for a halftone image, wherein:
printing areas define a non-orthogonal minimum mesh and extend first with darkening tone along directions other than those of their closest spacing.

2. A pattern according to claim 1 wherein:
the printing areas extend along the direction of second or third closest spacing.

3. A pattern according to claim 1 wherein:
the printing areas have an oval shape.

4. A screen system for use in production of a coloured halftone image, wherein:
a plurality of different screens each represent different colours or black in the image,
each screen has a pattern of printing areas which defines a minimum mesh,
the minimum meshes of at least two screens are non-orthogonal and have printing areas which extend to join first along directions other than that of their closest spacing.

5. A screen system according to claim 4 wherein:
all of the screens have non-orthogonal meshes.

6. A method of preparing a halftone pattern, comprising:
receiving information representing tone variation in an image,
creating a pattern of printing areas which represents the variation by;
forming the pattern to define a non-orthogonal minimum mesh, and
varying the printing areas by extension toward nearby areas other than their nearest neighbours.

7. A method according to claim 6 further comprising:
extending the printing areas toward their second or third nearest neighbours.

8. Any Computer apparatus which produces a screen system or implements a method according to any one of claims 4 to 7.

Claim by result

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9. A pattern for a halftone image substantially as hereinbefore described with reference to the accompanying drawings.

10. A screen system for use in production of a coloured halftone image substantially as hereinbefore described with reference to the accompanying drawings.

11. A method of preparing a halftone pattern substantially as hereinbefore described with reference to the accompanying drawings.

12. Each and every invention herein described.

Megadot Systems Ltd
By the authorised agents
A. J. PARK & SON
Per

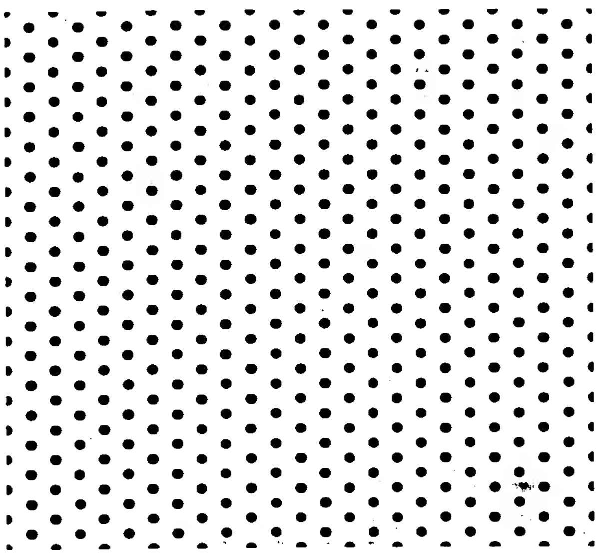


Fig 1a

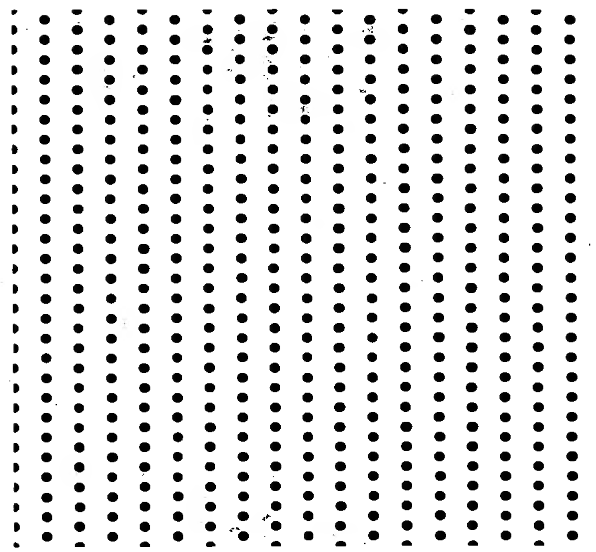


Fig 1b

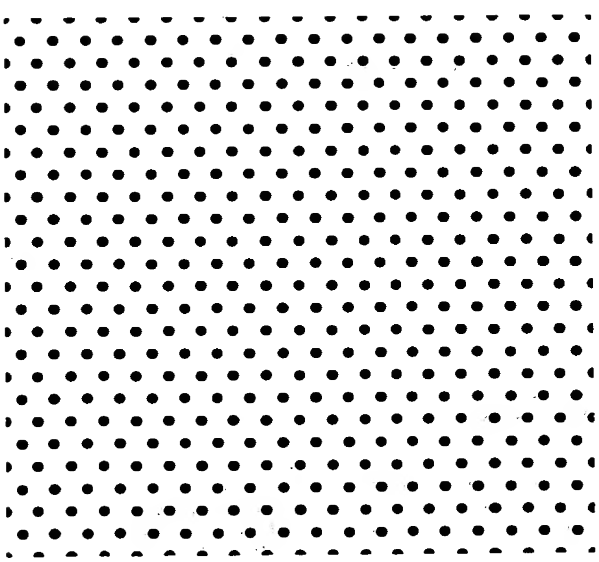


Fig 1c

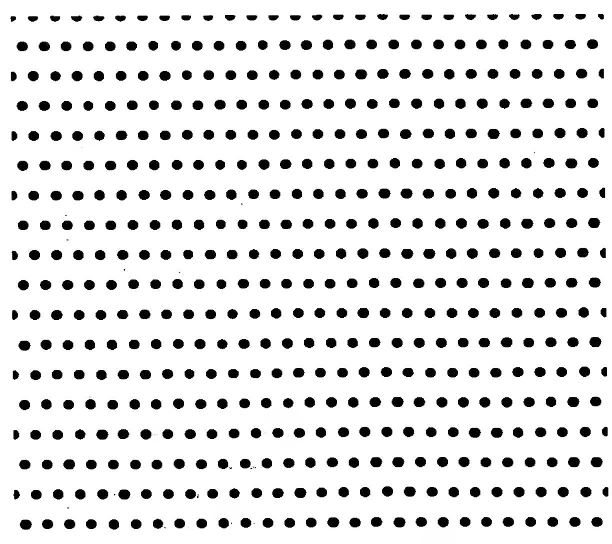


Fig 1d

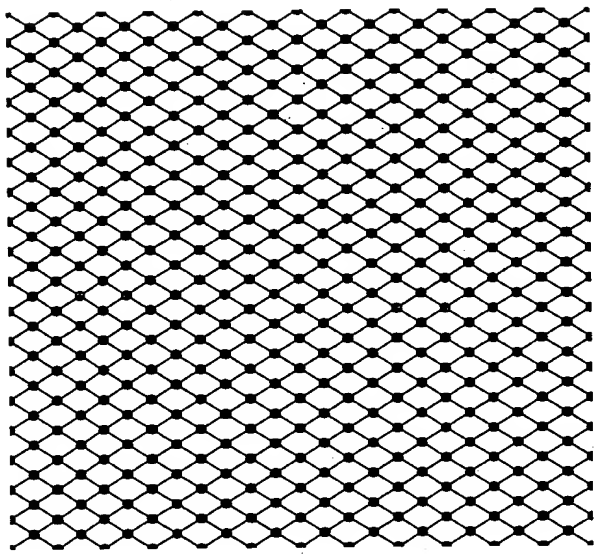


Fig 2a

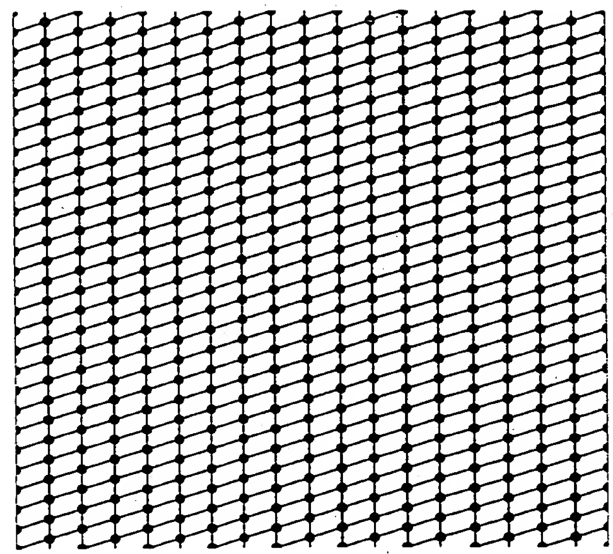


Fig 2b

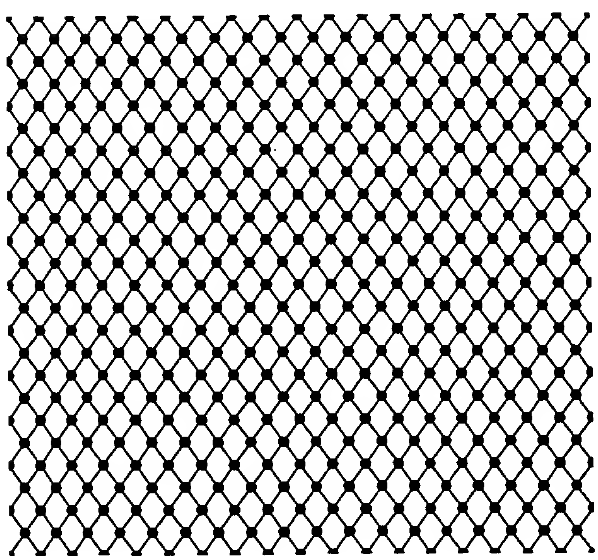


Fig 2c

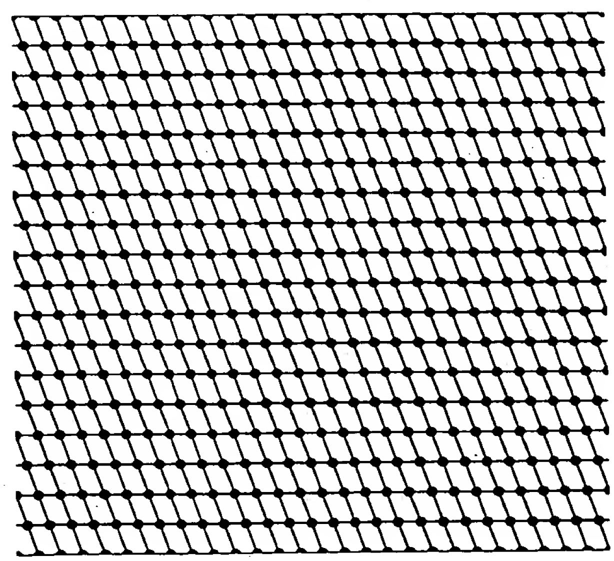


Fig 2d

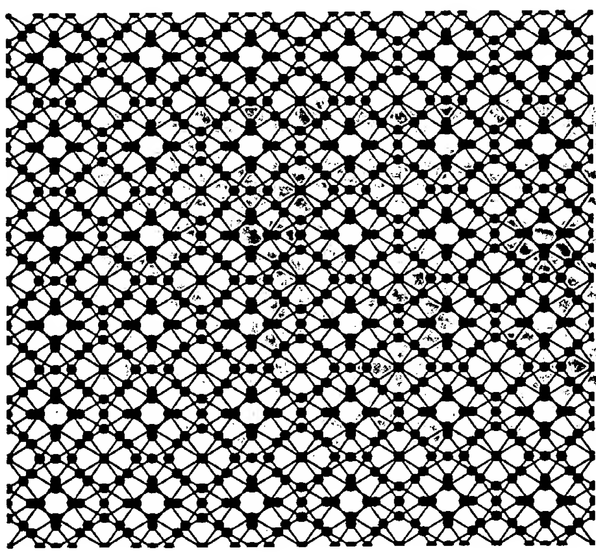


Fig 3a

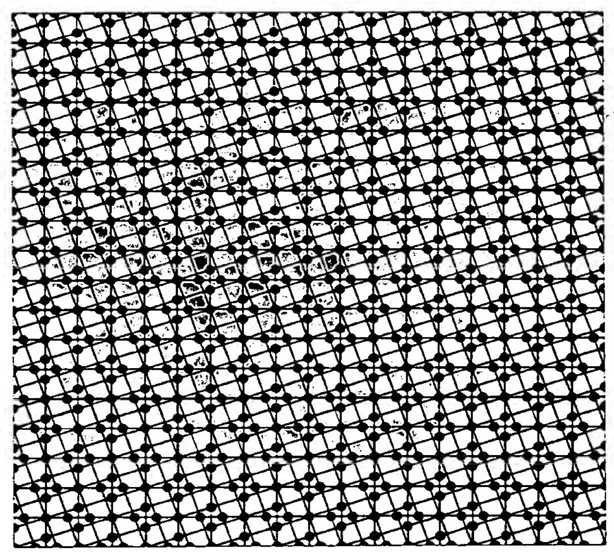


Fig 3b

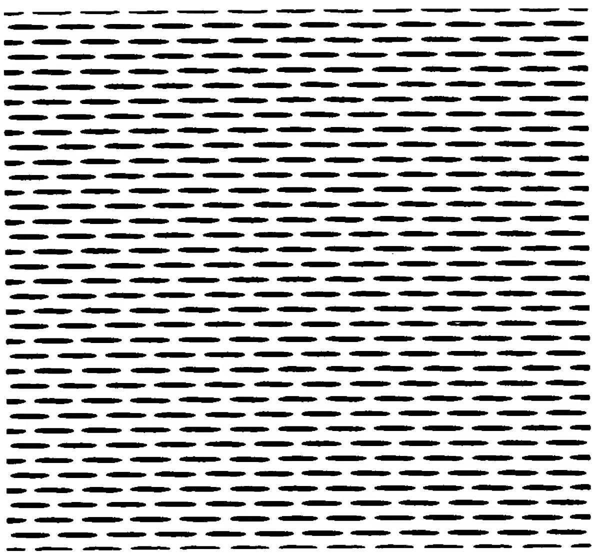


Fig 4a

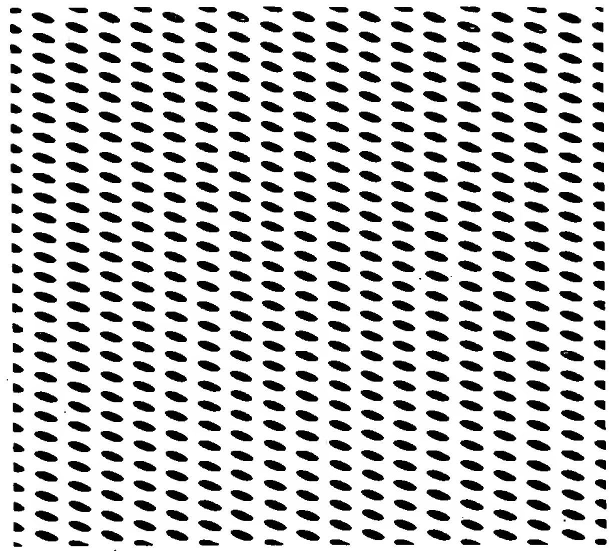


Fig 4b

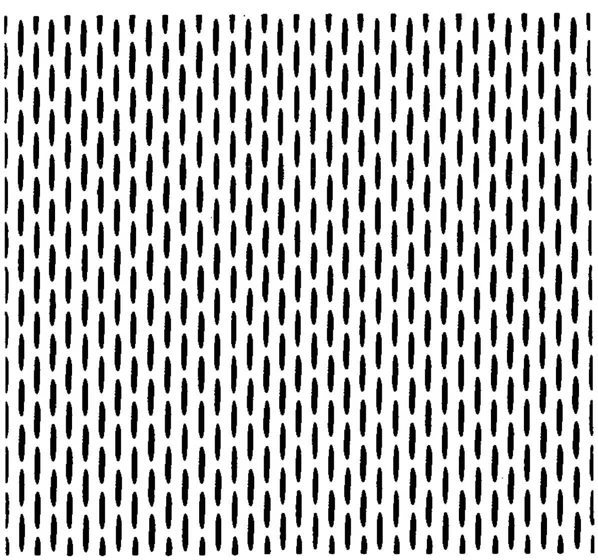


Fig 4c

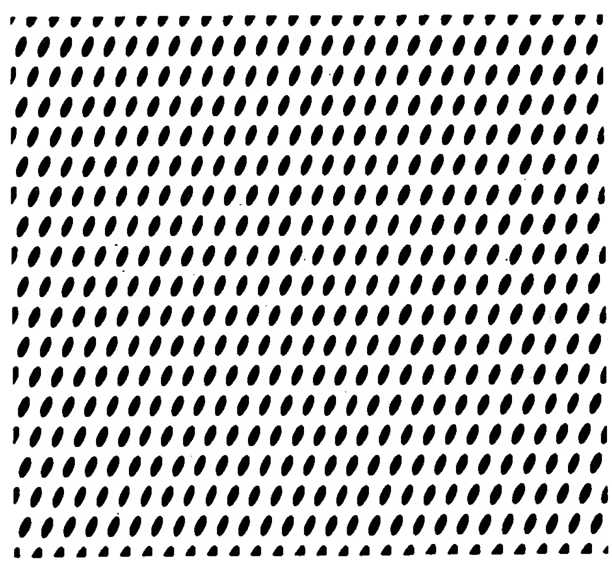


Fig 4d

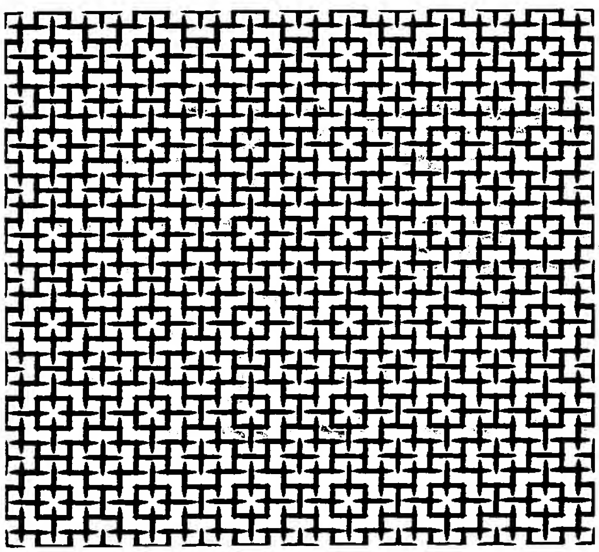


Fig 5a

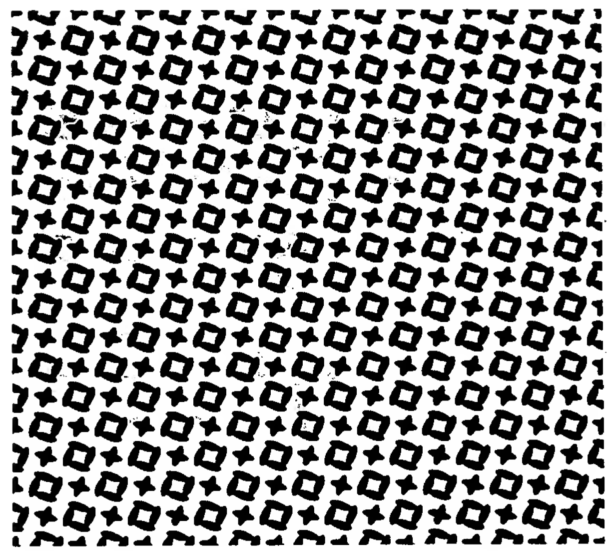


Fig 5b

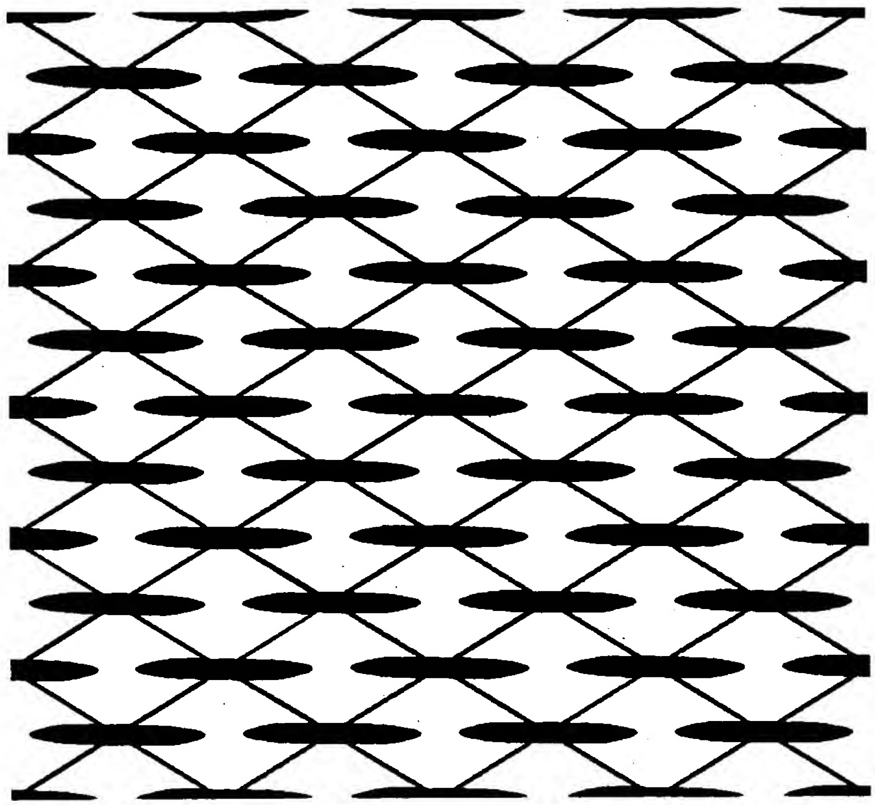


Fig 6a

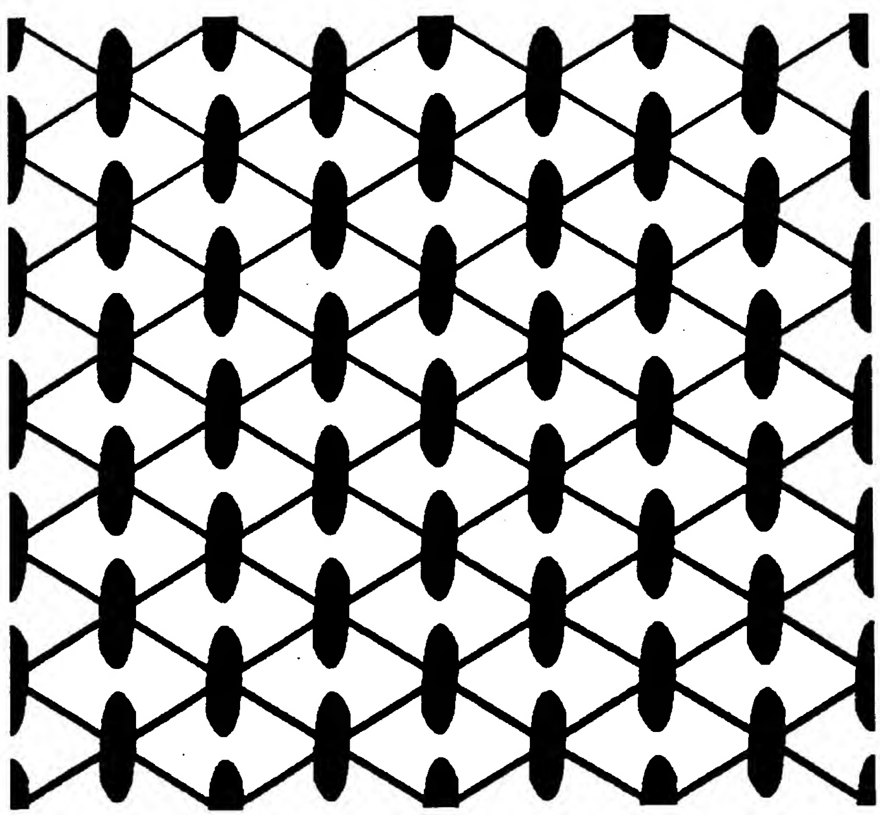


Fig 6b

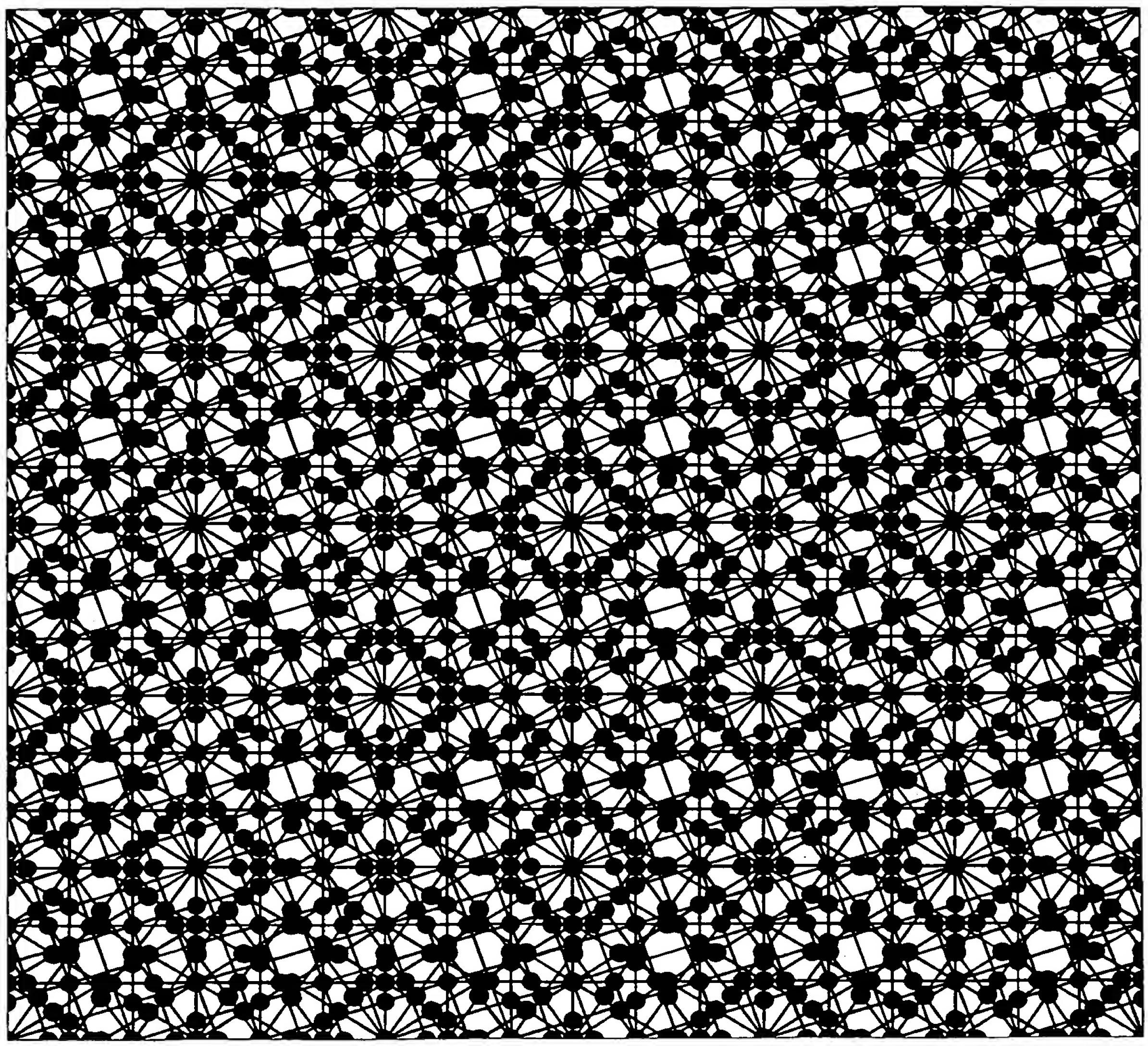


Fig. 7

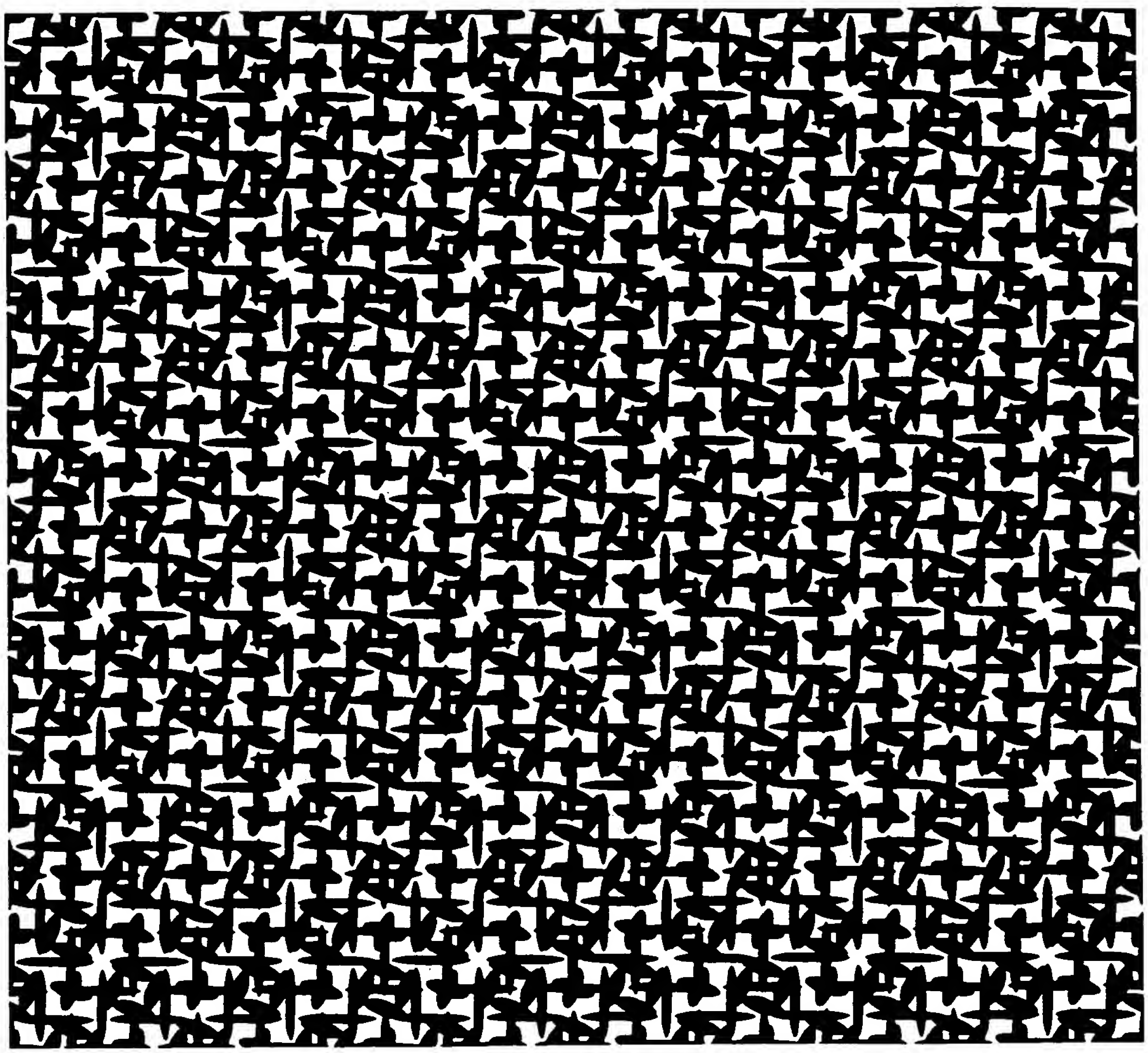


Fig 8

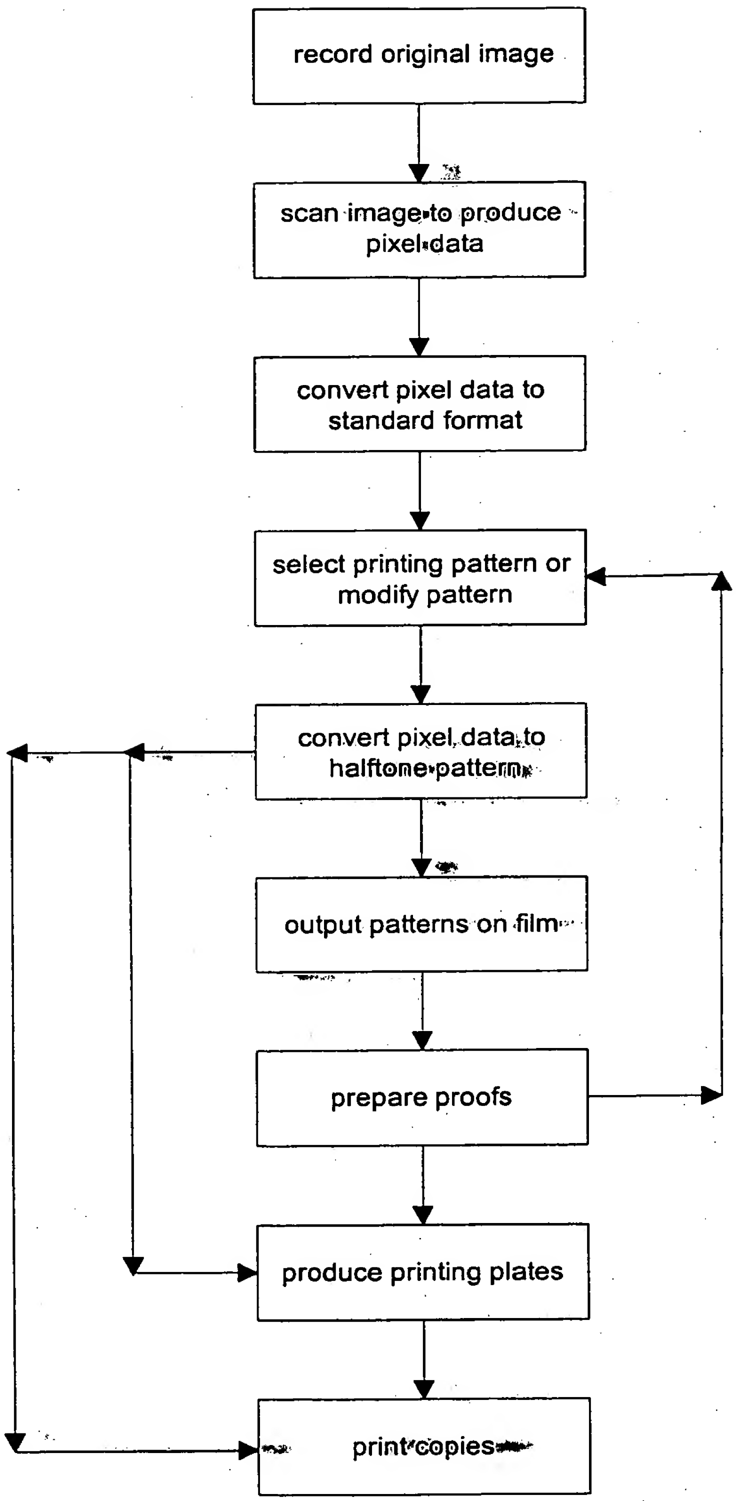
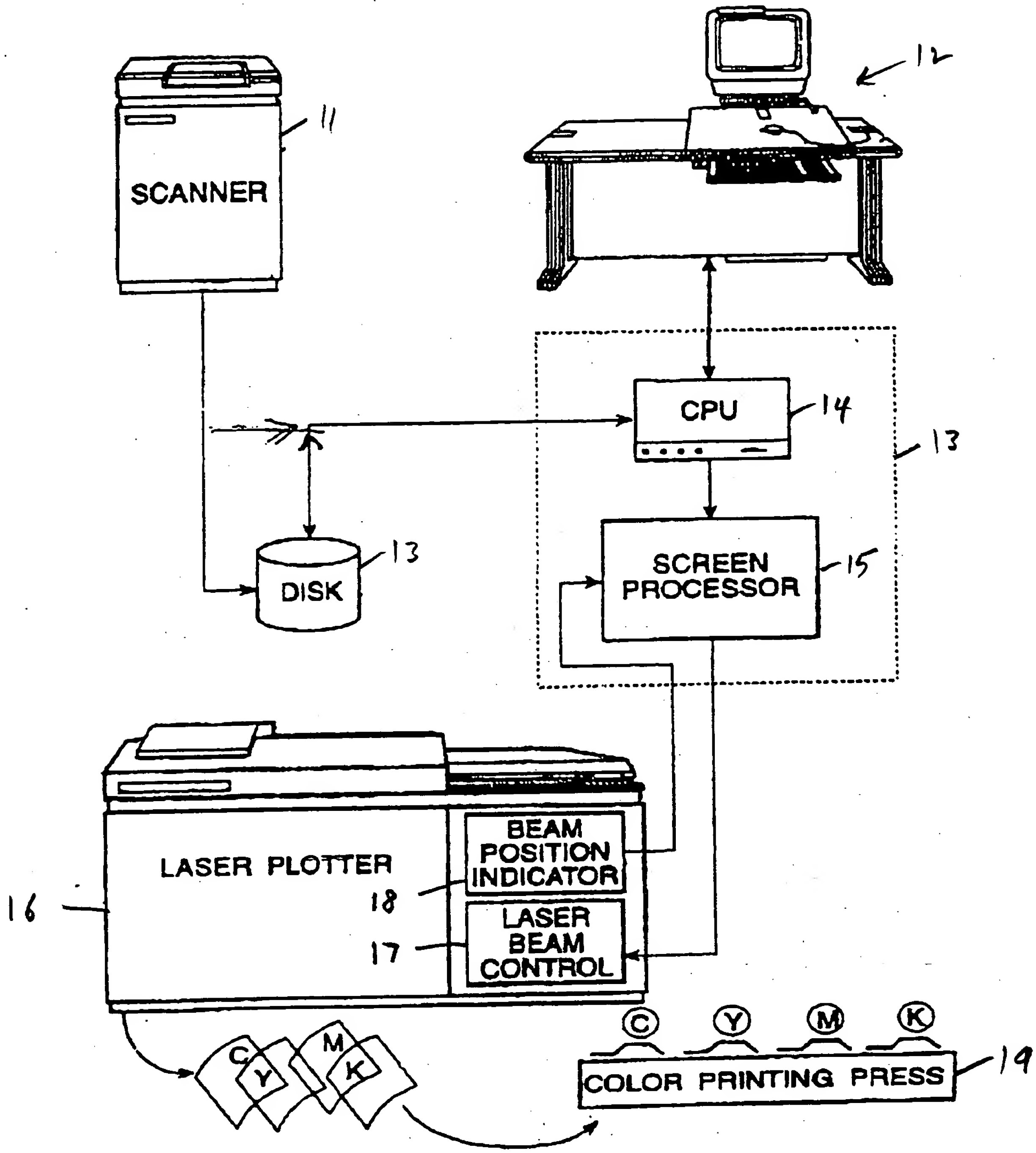

record original image
scan image to produce pixel data
convert pixel data to standard format
select printing pattern or modify pattern
convert pixel data to halftone pattern
output patterns on film
prepare proofs
produce printing plates
print copies

Fig 9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COLOR PRINTING PRESS
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Fig 10